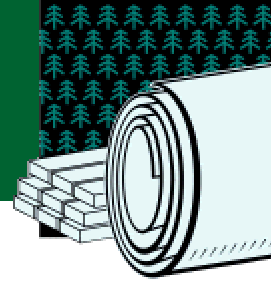
FOREST PRODUCTS
Project Fact Sheet



CFD MODELING, SHAPE OPTIMIZATION, AND FEASIBILITY TESTING OF ADVANCED BLACK LIQUOR NOZZLE DESIGNS FOR IMPROVED ENERGY EFFICIENCY

BENEFITS

- Improved boiler efficiency
- Reduced sulfur emissions
- Reduced down time
- Increased pulp production

APPLICATIONS

The optimized nozzle designs will improve the efficiency of recovery boilers. Designs will be customized for each specific furnace with the advanced CFD modeling capabilities developed during the project.

Optimizing Splash-Plate Nozzles Will Improve Efficiency of Kraft Recovery Boilers

The energy performance, combustion performance, and capacity of kraft recovery boilers are highly sensitive to the black liquor spray drop size and distribution in the furnace. New designs for splash-plate black liquor nozzles can improve the quality of black liquor drops and thus enhance boiler efficiency.

This project focuses on improving the quality of black liquor drops by controlling drop size and drop size distribution in nozzles. Researchers will use Computational Fluid Dynamics (CFD) techniques in order to model the formation and trajectory of black liquor sprays and to subsequently develop better nozzle designs. The resulting nozzle designs are expected to increase combustion efficiency and reduce boiler fouling and plugging.

OFFICE OF INDUSTRIAL TECHNOLOGIES
ENERGY EFFICIENCY AND RENEWABLE ENERGY • U.S. DEPARTMENT OF ENERGY

PROJECT DESCRIPTION

Goal: Improve the energy efficiency of the recovery boiler by optimizing splash-plate nozzle performance.

Splash-plate nozzles are pressurized-atomizing nozzles that form droplets by first forming sheets of liquid at the edge of a stationary surface or splash-plate. Aerodynamic forces then induce waves in the fluid sheet. The amplitude of these waves increases with time, causing the sheet to break into ligaments and form into droplets.

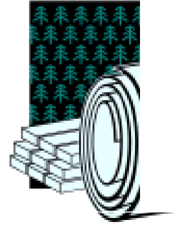
Researchers will focus on producing droplets of desired size (~3 mm) with a very narrow size distribution and on producing a uniform distribution of liquor spray within the furnace. Laboratory testing will involve determining the phenomena driving Helmholtz wave formation, subsequent drop formation, and drop size distribution. Using Computational Fluid Dynamics (CFD) modeling of drop formation, researchers will simulate experimental data and predict spray characteristics for commercial-scale nozzles over a range of operating conditions. Physical and numerical modeling will be conducted to design and test full scale nozzles under industrial conditions.

PROGRESS & MILESTONES

- Researchers designed a spray atomization chamber in December 2000 that meets experimental data collection and INEEL safety and health requirements.
- A preliminary non-dimensional analysis indicated that a spray booth capable of accommodating a 1/4 to 1/3 scale nozzle would be appropriate.

Future milestones include:

- Complete modeling of industry partner's facility to benchmark current designs and performance;
- Complete initial laboratory analysis of vibratory-assisted splash plates;
- Complete preliminary algorithms, including parameter specification, describing spray formation;
- Complete model optimization of nozzle spray distribution; and
- Results will be evaluated for industrial scale field testing



PROJECT PARTNERS

Babcock & Wilcox Company
Barberton, OH

Bechtel BWXT Idaho, LCC
Idaho Falls, ID

Boise Cascade Corporation
Boise, ID

Idaho National Engineering and Environmental Laboratory
Idaho Falls, ID

International Paper Company
Loveland, OH

McDermott Technologies, Inc.
Alliance, OH

Weyerhaeuser Company
Tacoma, WA

FOR ADDITIONAL INFORMATION PLEASE CONTACT:

Gideon Varga
Office of Industrial Technologies
Phone: (202) 586-0082
Fax: (202) 586-3237
e-mail: gideon.varga@ee.doe.gov

Dr. Brent Detering
Idaho National Engineering and Environmental Laboratory
P.O. Box 16255
Idaho Falls, ID 83415-2210
Phone: (208) 526-1720
e-mail: bad@inel.gov

Please send any comments, questions, or suggestions to webmaster.oit@ee.doe.gov

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Office of Industrial Technologies
Energy Efficiency and Renewable Energy
U.S. Department of Energy
Washington, D.C. 20585

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